

Estimation of Air Pollution Tolerance Index of Plants Across the Industrial Zone in Kanpur City, Uttar Pradesh

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Abstract— One of the world's most serious issues today is air pollution caused by vehicle emissions, which poses a serious threat to both the environment and the health of living things (plants, humans, animals, microorganisms). The most severely impacted plants are those growing along side roadsides because they are the ones most frequently exposed to various air pollutants and exhibit a range of tolerance and sensitivity. In light of this, the current study's foundation was an evaluation of seasonal variation in the air pollution tolerance index (APTI). One of the most important sources of air pollution is vehicle emissions. The 11th most highly populated city in India is Kanpur. The parameter used to evaluate the sensitivity and tolerance level of plants based on Air Pollution Tolerance Index (APTI). This study aims to calculate the resistance and sensitivity of various plant species to air pollution. In the majority of developing countries, one of the causes of air pollution is vehicular emissions. Planting along the side of the road is a significant method of reducing the pollution that cars emit. The plants' APTI value is calculated using the pH, relative water content (RWC), total chlorophyll (Tch), and ascorbic acid (Asc) content of the leaves. The leaves of plants were collected from industrial zones Northern railway colony. Based on APTI values, In the industrial area, the most tolerant plant *Ficus benghalensis* (38.40) and *Azadirachta indica* (31.16), while lowest APTI value plants species *Alstonia scholaris* (9.5) and *Adina cordifolia* (11.6.0) in the industrial zone.

Keyword— Vehicular pollution, Total chlorophyll, Ascorbic acid, Air pollution tolerance index (APTI).

I. INTRODUCTION

Due to the world's rapid population growth, especially in developing nations, where there are heavy industrial, vehicular particulate, and gaseous pollutants, environmental pollution is a significant concern in urban areas (Kumar et al., 2015a). Communicated the issue has multiplied over the last few decades, endangering both people and the ecosystem severely. Other human activities have exacerbated pollution and its detrimental effects on people and the environment, including open dumping of industrial and hospital waste and the burning of firewood, which is particularly problematic due to incomplete combustion (Hatamimanesh et al., 2021). Morphological, biochemical, and physiological characteristics (Yadav & Pandey, 2020). Plant selection and biomonitoring are important for developing sustainable landscape plans for industrial and urban civic centers (Walia et al., 2019). Landscaping urban areas with plants offers social, health,

environmental and economic benefits, but most recently, urban

landscaping has become important for improving air quality (Shrestha et al., 2021). Correct selection of ornamental plant species and adopting proper landscape design may change the view of the urban landscape and will help in environment amelioration. APTI values range from 1 to 100 and classified as presented in Table 1.

Table 1. Classification of plants based on APTI values (Sharma et al., 2017)

APTI value	Category of plant
<1	Very sensitive
1–16	Sensitive
17–29	Intermediate
30–100	Tolerant

As bio-indicators of pollution, plants with higher APTI values are more tolerant of air pollution than those with lower APTI values (Mukhopadhyay et al., 2021). The plants can be categorised as very sensitive, sensitive, sensitive, intermediate, and tolerant plants based on their indices (Ahmad et al., 2019; Kaviani et al., 2021). Antioxidant ascorbic acid helps protect plants from oxidative damage caused by aerobic metabolism, photosynthesis, and various contaminants (Zhang et al., 2016). The current study's objective was to determine which plant species in Kanpur, Uttar Pradesh, had the highest air pollution tolerance index (APTI).

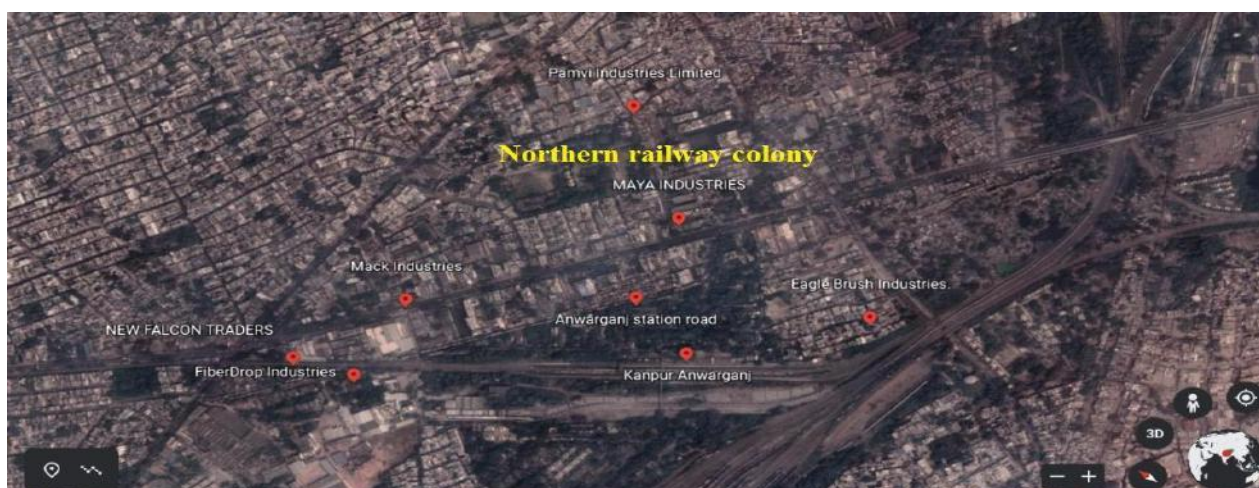


Fig.1 location of northern railway colony, Kanpur (source: [Google Maps](#))

SAMPLING OF LEAVES

In industrial area during the month of May 2022, fresh leaves from each plant were collected for the study. Table 2 displays the plant species that were selected from sites.

Table 2 Zone (Northern railway colony : industrial area)

Plant name	Common name
<i>Polyalthia longifolia</i>	Ashoka tree
<i>Azadirachta indica</i>	Neem
<i>Ficus religiosa</i>	Peepal tree
<i>Ficus benghalensis</i>	Banyan tree
<i>Solanum pseudocapsicum</i>	Jerusalem Cherry
<i>Agle marmelos</i>	Bael
<i>Mangifera indica</i>	Mango
<i>Psidium gulajaval</i>	Guava
<i>Lonicera nigra</i>	Black-berried honeysuckle
<i>Adina cordifolia</i>	Haldina cordifolia
<i>Alstonia scholaris</i>	blackboard tree
<i>Carcabela thevetia</i>	yellow oleander

II. MATERIAL AND METHOD STUDY AREA

Kanpur, a city of Uttar Pradesh (U.P.) is the study location being considered for the current research. Due to the uncontrolled population growth, industrialization, urbanization, and increase in the number of vehicles on the roadways, environmental issues in the area have been becoming worse. With a population of more than 4 million (Dixit et al., 2022). The current study was carried out at location of northern railway colony, Kanpur.

APTI

The following mathematical expression was used to combine the ascorbic acid content, leaf extract pH, total chlorophyll content, and relative water content to calculate the APTI of various plant species. (Sharma et al., 2017). APTI of the plants were measured by the eq. (1)

$$APTI = \frac{A(T+P)+R}{10} \quad (1)$$

Where: P : pH of the leaf extract, A : Ascorbic acid concentration (mg/gm), T: total chlorophyll (mg/gm), R : relative water content of leaf (%).

RWC

By weighing the fresh leaves, you can get a fresh weight. The leaves were then submerged in water for an entire night, blotted, dried, and weighed to determine their turgid weight (Zhang et al., 2016). The leaves were reweighed to determine the dry weight after being dried overnight in an oven at 70 °C. Barr and Weatherly used the following formula to determine and calculate RWC: Eq (2).

$$RWC (\%) = \frac{(FW-DW) \times 100}{TW-DW} \quad (2)$$

Where,

FW = Fresh weight, DW = Dry weight, TW = turgid weight.

Tch

0.5 g of leaf samples were homogenised in 80% acetone and centrifuged to determine the amount of total chlorophyll. Using a spectrophotometer, the supernatant's absorption at 663 and 645 nm was measured. eq 3 (a)-(c) proposed by Arnon in 1949; Kaur & Nagpal in 2017 was used to calculate the contents of chlorophyll a, chlorophyll b, and total chlorophyll.

$$\text{Chlorophyll a (mg/L): } 12.7 \times A_{663} - 2.29 \times A_{645} \quad 3(a)$$

$$\text{Chlorophyll b (mg/L): } 22.9 \times A_{645} - 4.68 \times A_{663} \quad 3(b)$$

$$\text{Total chlorophyll (mg/L): } 20.2 \times A_{645} + 8.02 \times A_{663} \quad 3(c)$$

pH

5.0 g of fresh leaves were homogenized in 10 ml distilled water. Leaf extract filtered and the pH determined after calibrating pH meter with a buffer solution of pH 4, 7 and 9 (Bharti et al., 2018; Veni et al., 2014).

Asc

The 2,6, Dichlorophenol indophenol dye was used in the Titrimetric method of Sadasivam (1987) to evaluate the ascorbic acid level. 500 mg of leaf material were extracted with 4% oxalic acid and titrated with the dye until a pink color appeared (Kumar et al., 2015b).

III. RESULT AND DISCUSSION

The estimated values of APTI with plants biochemical parameters for both the locations are presented in the Table 3.

Table 3. Reprehensive APTI for plants northern railway colony (industrial)

Plant Name	RWC	Ph	Tch Asc	APTI	Tolerance class
<i>Polyalthialongifolia</i>	66.21	6.84	29.25 6.72	30.87	Tolerant
<i>Azadirachta indica</i>	54.12	6.41	16.5 11.24	31.16	Tolerant
<i>Ficus religiosa</i>	60.52	5.3	9.6 6.94	16.39	Intermediate
<i>Ficus benghalensis</i>	55.61	5.41	16.2 15.2	38.40	Sensitive
<i>Solanum pseudocapissum</i>	55.55	6.79	26.41 6.64	27.59	Intermediate
<i>Agle marmelos</i>	63.41	6.84	21.98 5.94	23.46	Intermediate
<i>Mangifera indica</i>	51.3	6.91	15.2 8.4	23.70	Intermediate
<i>Psidium gulajaval</i>	52.7	6.59	19.5 6.5	22.22	Intermediate
<i>Lonicera nigra</i>	42.72	6.27	37.78 7.49	29.61	Sensitive
<i>Adina cordifolia</i>	51.32	7.8	3.91 5.51	11.60	Sensitive
<i>Alstonia scholaris</i>	50.44	6.06	3.89 4.5	9.52	Sensitive
<i>Carcabela thevetia</i>	59.18	6.9	3.82 5.93	12.27	Sensitive

As the above table show the variation of APTI value of each plant 9.52 to 38.40.

APTI values of plants in ascending order as *Alstonia scholaris* < *Adina cordifolia* < *Carcabela thevetia* < *Ficus religiosa* < *Psidium gulajaval* < *Agle marmelos* < *Mangifera indica* < *Solanum pseudocapisum* < *Polyalthia longifolia* < *Azadirachta indica* < *Ficus benghalensis*

IV. CONCLUSION

In order to better understand and control air quality, the current study provides a framework for selecting the right plant species based on score. The APTI is a helpful tool for selecting plants for the creation of green belts to reduce pollution. Tolerant plant species can lessen the negative effects of long-term exposure to air pollution. The current study makes recommendations for the best suitable plants for the development of a green belt in an industrial zone to the relevant authorities and environmental protection organisations. As per the results, the most tolerant plant *Ficus benghalensis* (38.40) and *Azadirachta indica* (31.16), while and *Polyalthia longifolia* (17.84) and *Nerium indicum* (16.23) are the best suited plant for industrial area. while lowest APTI value plants species *Alstonia scholaris* (9.5) and *Adina cordifolia* (11.6.0) in the industrial zone.

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